City of Portsmouth, New Hampshire
Wastewater Master Plan

Phase 2 Initial Piloting Technical Memorandum

Volume One of Two

September, 2012

STATE OF NEW HAMPSHIRE
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September 28, 2012

Mr. Terry Desmarais, P.E.
City Engineer
Department of Public Works
680 Peverly Hill Road
Portsmouth, NH 03801

Subject: Wastewater Master Plan (WWMP) Phase 2 Initial Piloting
Piloting Technical Memorandum

Dear Mr. Desmarais:

In accordance with our Agreement, we are pleased to submit this Technical Memorandum on the Phase 2 Initial Piloting of potential technologies to upgrade the Peirce Island Wastewater Treatment Facility (WWTF). The recommendations in this Technical Memorandum were prepared to fulfill the requirements of the modified Consent Decree that requires that "The City shall submit a Piloting Technical Memorandum that includes data from piloting and a recommendation on the design and capacity of secondary treatment facilities".

This Technical Memorandum presents the approach, equipment, methods, and results of the pilot study of the three treatment technologies selected in the Phase 1 Engineering Evaluation for piloting:

- Biological Aerated Filter (BAF)
- Conventional Activated Sludge with BioMag (CASB)
- Moving Bed Bioreactor (MBBR) & DAF

The piloting data showed that all three technologies were capable of achieving the effluent goals of the pilot study for secondary treatment (30 mg/l Biochemical oxygen demand (BOD) and 30 mg/l total suspended solids (TSS)) as well as for the effluent total nitrogen goal of 8 mg/l. All three technologies were able to intermittently, but not consistently, achieve the effluent total nitrogen goal of 3 mg/l.

The Technical Memorandum also includes updated data on wastewater characteristics and revised flows and loads for the WWTF upgrade. Updated process sizing, layouts, and estimated costs for upgrading the WWTF to provide secondary treatment with the ability to meet an effluent total nitrogen limit of 8 mg/l for each of the three technologies are presented. Based on the estimated capital and operation and maintenance costs, as well as consideration of non-monetary factors, the three technologies were compared.

Based on the evaluation and comparison of the three piloted technologies, it is recommended that the City pursue preliminary design of a BAF for secondary treatment sized to treat an average daily flow of 6.13 mgd, and the preliminary design include the ability to meet an effluent total nitrogen of 8 mg/l on a seasonal rolling average basis.

For the purposes of the pilot performance analysis and preliminary design, effluent is considered to be at the downstream end of the proposed secondary (nitrogen removal) treatment system. This is not inclusive of the wet weather treatment effluent, which will be considered as a separate flow from secondary effluent and measured independently. The recommended treatment technology was based on meeting treatment levels summarized below:

- Secondary Treatment: In accordance with the secondary treatment permit limits as summarized in the 2007 NPDES permit. The permit limits require meeting an effluent TSS and BOD of 30 mg/l or less on a monthly average basis, 45 mg/l on a maximum weekly basis and 50 mg/l on a maximum day basis and TSS and BOD percent removals of 85 percent. Achieving 85 percent removal for BOD and TSS will only be required on dry weather days.

- Total Nitrogen to 8 mg/l: Meeting a TN effluent limit of 8 mg/l on a seasonal rolling average basis from April to October. TSS and BOD limits for will be the same as stipulated above for Secondary Treatment.

We would be pleased to meet with you or other City staff to review and discuss the report findings and recommendations. If you should have any questions, please feel free to contact us.

Very truly yours,

Jon R. Pearson, P.E.
Vice President
AECOM

JRP/mtf

EXECUTIVE SUMMARY

The City of Portsmouth has been issued a Consent Decree by the US Environmental Protection Agency (EPA) to upgrade the existing Peirce Island Wastewater Treatment Facility (WWTF) to provide secondary treatment. In response to the requirements of the Consent Decree, the City has completed this Phase 2 Initial Piloting Technical Memorandum which includes data from piloting and a recommendation on the design and capacity of secondary treatment facilities. This data and the recommendations are presented in seven sections comprising the Initial Piloting Technical Memorandum and each section is described in more detail below.

SECTION 1 - INTRODUCTION AND PURPOSE

This section presents background information related to the Phase 2 Initial Piloting Technical Memorandum.

Introduction

This section describes the prior planning efforts conducted by the City to address the initial Consent Decree requirements and subsequent modifications to the Consent Decree including the following:

- The Draft WWMP/LTCP Update which recommended a preferred alternative of phased expansion of the Pease WWTF for treatment of sanitary (dry weather) wastewater, and conversion of the Peirce Island WWTF to a CSO treatment facility for wet weather flows.

- Following submittal of the Draft WWMP/LTCP the EPA indicated that the proposed schedule for implementation of the preferred alternative recommended in the Draft WWMP/LTCP Update was unacceptable. EPA encouraged the City to pursue a revised compliance strategy that focused on achieving secondary treatment of the Peirce Island sanitary flows as expeditiously as possible.

- The City promptly pursued a revised compliance strategy which was focused on upgrading the existing WWTF to secondary treatment using high rate, small footprint treatment technologies. The Final Wastewater Master Plan Submission (November 2010) identified a number of potential high rate secondary treatment technologies that could be implemented, identified the preliminary hydraulic sizing basis, and provided concept level estimated capital costs for construction of the identified treatment technologies. The Final Wastewater Master Plan Submission recommended that the technologies be piloted to determine the most applicable technology for use in upgrading the Peirce Island WWTF in the revised compliance strategy.

- The City conducted a Phase 1 Engineering Evaluation of potential high rate secondary treatment technologies to select the technologies to be piloted. As part of this evaluation existing flow and loading data for the Peirce Island WWTF were reviewed to identify projected dry weather flows and loadings for the proposed secondary treatment processes. The projected flows and loadings were used in developing conceptual planning level unit process sizes and estimated capital, operating, and maintenance costs for eight technologies. These technologies were evaluated on both a monetary and non monetary basis. Based on this evaluation the following technologies were selected for piloting:

    - Biological Aerated Filter (BAF)
    - Conventional Activated Sludge with BioMag (CAS-BioMg)
    - Moving Bed Bioreactor (MBBR) & DAF

Purpose

The focus of the Phase 2 Initial Piloting was to evaluate the ability of the three technologies to meet the secondary treatment effluent limits. With the recent indications from EPA that nitrogen removal will now be required as part of the upgrade of the Peirce Island WWTF, an additional focus of the pilot evaluation was to evaluate the ability of the three processes to meet effluent nitrogen levels of 8 mg/l and 3 mg/l. Other goals of the piloting effort included:

1. Complete a wastewater characterization program to define the loadings that the upgraded WWTF will be required to treat.
2. Establish the design flows for the upgraded WWTF.
3. Confirm Manufacturer/Vendor sizing criteria and space requirements to provide secondary treatment/nitrogen removal using each technology.
4. Define technology performance under varying flow conditions.
5. Identify operational and maintenance factors specific to each technology.

The results of the piloting effort have been used to prepare an updated evaluation and comparison of the three technologies to allow the City to select the technology for upgrading the Peirce Island WWTF.

Consent Decree Requirements

The Consent Decree between the City and EPA was executed in August 2009 and contained milestones and dates for the completion of the Draft and Final WWMP/LTCP Updates. During the course of the piloting evaluation, EPA and the City negotiated a modification to the Consent Decree which contains further milestones and dates for the upgrade of the Peirce Island WWTF to secondary treatment. This report has been prepared for submittal to the EPA to fulfill the October 1, 2012 Consent Decree milestone which states "The City shall submit a Piloting Technical Memorandum that includes data from piloting and a recommendation on the design and capacity of secondary treatment facilities".

SECTION 2 – PILOT PROCESS, EQUIPMENT, AND APPROACH

This section provides an overview of the three technologies and the piloting equipment and approach. A brief overview of the three technologies that were piloted is presented in this section followed by a description of the three piloted technologies. This section describes the layouts and components of the three piloted technologies as well as the common piloting systems utilized by the technologies. This section also describes the piloting approach of evaluating the three technologies including configuring and testing of the technologies for secondary treatment as well as nitrogen removal and the implementation of different influent flows and loading to assess the technologies.

SECTION 3 – PILOT DATA ANALYSIS

This section presents the analysis of the pilot data collected for three technologies. Items that are addressed for each technology include:

1. Summary of the Pilot Testing Experimental Plan
2. Summary of Experimental Plan Data
3. Summary of Technology's Ability to Meet Permit Goals
4. Vendor Provided Loading Rate Validation
5. Hydraulic Stress Tests Performance
6. Pilot Observations and Considerations for Full Scale Implementation

For each technology the items above are presented separately. At the end of the section the pilot data collected for the technologies are compared to each other. The general findings of the comparisons are as follows:

Ability to Meet Study Effluent Goals

All three technologies were deemed capable of achieving the effluent goals of the pilot study for secondary treatment (30 mg/l Biochemical oxygen demand (BOD) and 30 mg/l total suspended solids (TSS)) as well as for the effluent total nitrogen goal of 8 mg/l. All three technologies were able to intermittently, but not consistently, achieve the effluent total nitrogen goal of 3 mg/l.

Effluent Performance Comparison

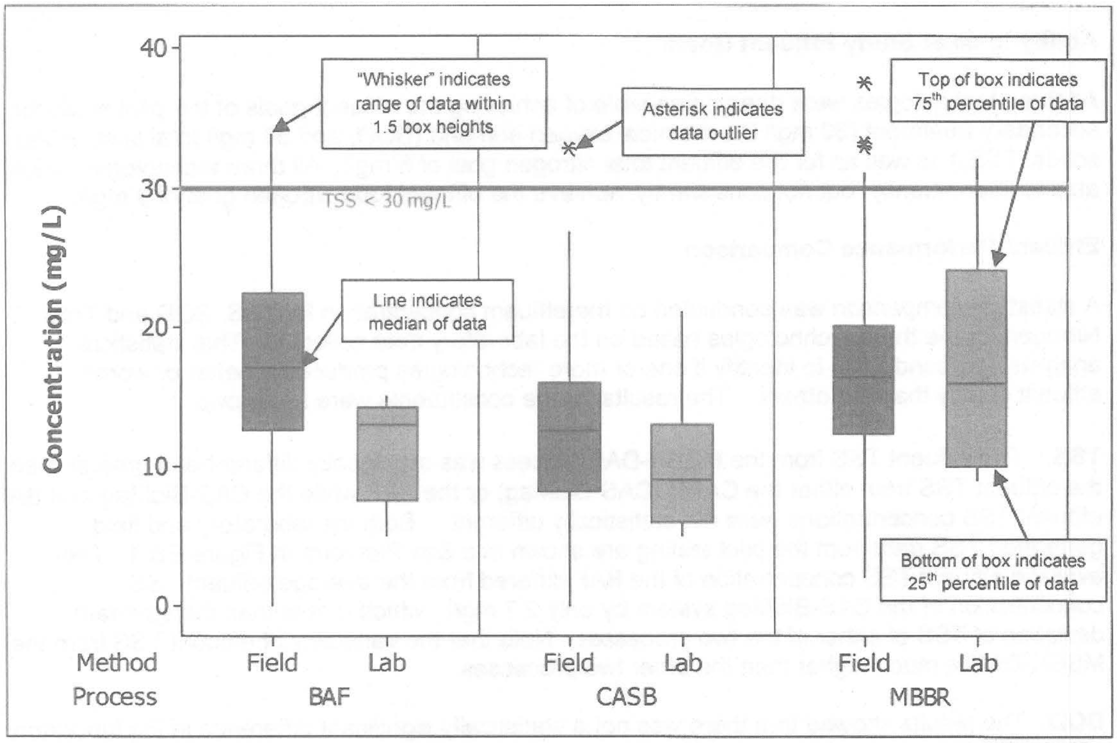
A statistical comparison was conducted on the effluent concentration for TSS, BOD and Total Nitrogen for the three technologies based on the laboratory data collected. This statistical analysis was conducted to identify if one or more technologies produced a better or worse effluent quality than the others. The results for the constituents were as follows:

TSS. The effluent TSS from the MBBR-DAF process was statistically different and greater than the effluent TSS from either the CASB (CAS-BioMag) or the BAF while the CAS-BioMag and BAF effluent TSS concentrations were not statistically different. Both the laboratory and field generated TSS data from the pilot testing are shown in a Box Plot form in Figure ES-1. The average effluent TSS concentration of the BAF differed from the average effluent TSS concentration of the CAS-BioMag system by only 2.7 mg/L, which is less than the standard deviation of TSS of either of the two processes. Note that the variability of effluent TSS from the MBBR-DAF is much higher than the other two processes.

BOD. The results showed that there was not a statistically significant difference in the laboratory effluent BOD concentrations between technologies. The BAF process had higher median effluent BOD than the other two processes, but the statistical test could not detect a difference because there were only three lab samples collected for BOD. Both the laboratory and field generated BOD data from the pilot testing are shown in a Box Plot form in Figure ES-2. Similar to the results for the effluent TSS, the effluent BOD from the MBBR process had a high amount of variability relative to the other processes.

Total Nitrogen. In this analysis there are five processes being compared, with CASB4 representing the four-stage conventional activated sludge process (for CAS-BioMag), and MBBR5 representing the 5-stage MBBR process (MBBR-DAF), both used for TN removal below 3 mg/L. There was only one configuration of the BAF process tested. The data is from the experimental plans conducted with high influent ammonia loading. The results showed that there was not a statistically significant difference between effluent TN concentrations for the five processes evaluated. The four-stage CASB process had the lowest effluent average TN of 3.1 mg/L, while the "normal" 2-stage MLE CASB had the highest effluent TN concentration of 5.8 mg/L. Figure ES-3 shows the box plot for both the field and laboratory analyses of TN for all processes. Both the laboratory and field generated TN data from the pilot testing are shown in a Box Plot form in Figure ES-3.

Figure ES-1. Box Plot of Effluent TSS for All Processes, All Experimental Plans

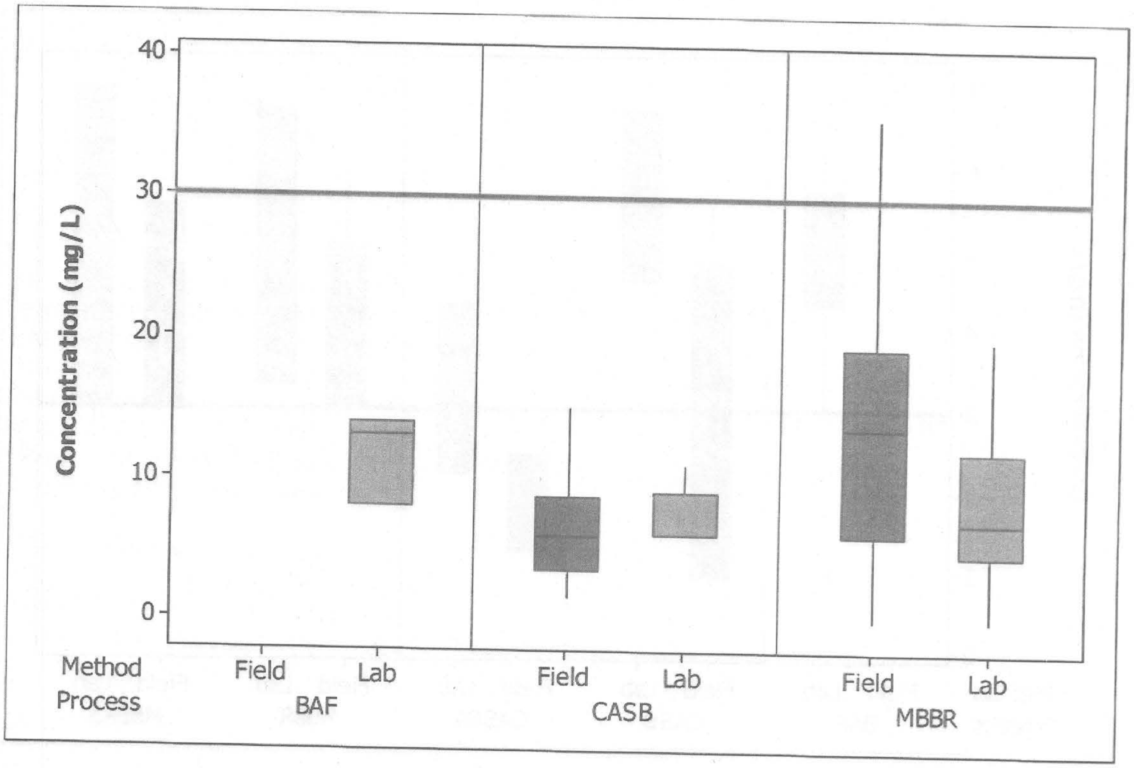


Vendor Constituent Loading Rate Validation and Potential to Reduce Technology Size

As part of the piloting effort, the technology vendors provided design loading rates for the various elements of their processes (BOD, nitrification, and denitrification). The data collected during the experimental plans were evaluated to validate vendor provided loading rates and confirm if their proposed process/equipment sizing were adequate for meeting the treatment goals of the Peirce Island WWTF. The vendor loading rates and collected data were also examined to assess if there was the potential for optimizing the process (i.e. potential to reduce the process equipment size) in a full scale installation. The results are as follows:

- All design loading rates and process equipment sizes provided by the vendor were validated.
- All technologies had the potential to increase their loading rates for BOD removal. However the ability to provide this modification is dependent upon if dedicated carbon removal or combined carbon removal/nitrification zones/stages are used.
- Only the MBBR-DAF showed the potential to increase their nitrification loading rate.
- Only the MBBR-DAF showed the potential to increase their denitrification loading rate.

Figure ES-2. Box Plot of Effluent BOD for All Processes, All Experimental Plans

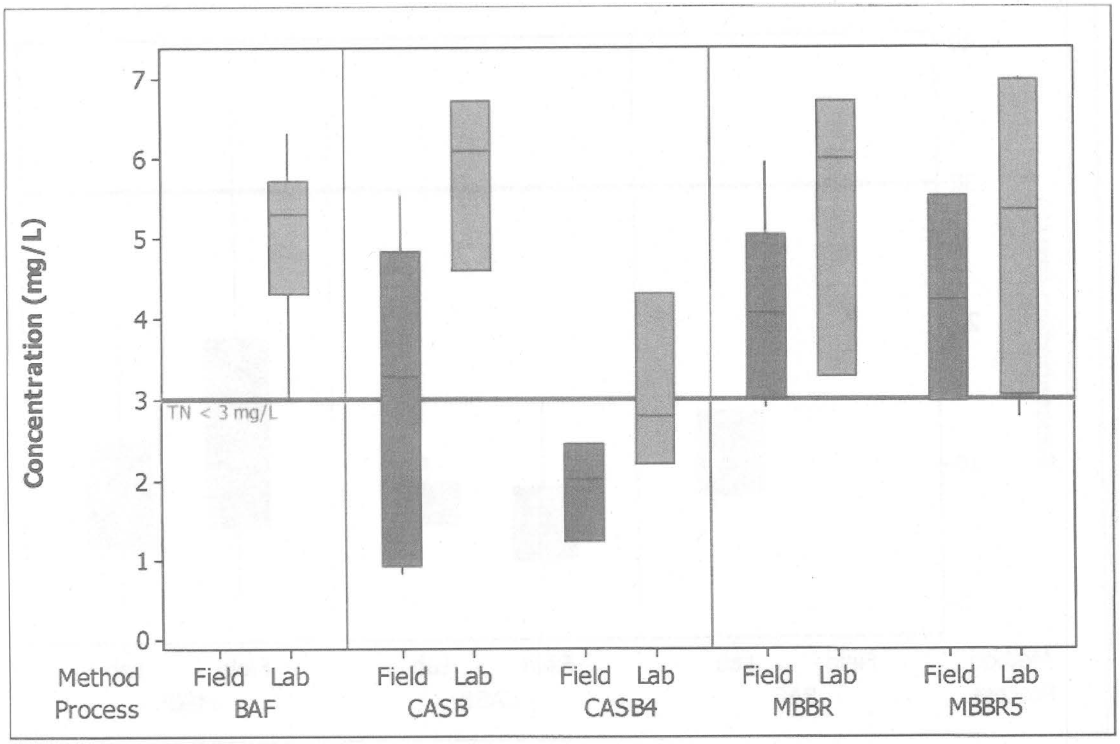


Hydraulic Stress Test Summary

As part of the piloting effort, each technology was run under different hydraulic stress conditions to assess its ability to perform and recover from the stress condition as well as determine if there was any biomass washout. This was done to simulate the effects of wet weather flows in the combined sewer system. None of the processes were observed to lose biomass as a result of the increased flow rates. It should also be noted that the only process changes that were made to both the BAF and MBBR-DAF systems during the tests was the increase in the influent flow. However, process changes to the CAS-BioMag system were made (DO increase and RAS flow rate increase) during its stress tests.

Both the BAF and MBBR-DAF effluents exceeded total nitrogen limit of 8 mg/l during a portion of the high stress conditions (as the result of dissolved oxygen suppression and incomplete nitrification) , but generally recovered within four to six hours after the flow condition was returned to pre-stress conditions. None of the hydraulic stress tests caused the CAS-BioMag process effluent to exceed total nitrogen limit of 8 mg/L. However again it should be noted that process adjustments were made to the BioMag system during the stress tests that were not made to the other technologies.

Figure ES3. Box Plot of Effluent TN for All Processes, Experimental Plans-05/06



SECTION 4 – WASTEWATER DATA AND REVISED FULL SCALE DESIGN CRITERIA

This section presents updated data on wastewater characteristics and revised information regarding the sizing and design criteria for the proposed upgrade of the Peirce Island WWTF.

Wastewater Characterization Program

A wastewater characterization program was conducted to provide data on the different constituents within Portsmouth's wastewater. The program included sampling and analysis of both the Peirce Island WWTF influent wastewater and the CEPT effluent and was performed over an extended period of time to quantify seasonal changes in wastewater characteristics. Section 4 presents the data collected which shows the WWTF influent is characteristic of a medium strength wastewater with a high degree of variability.

Revised Flows and Loads

As part of the first phase of the Wastewater Master Plan Piloting work, an analysis of data on influent wastewater flows and loads was conducted. Since that submittal was prepared, several conditions warrant revision of the projected flows and loadings. The conditions included the following:

- EPA's indication that the projected flows for the Peirce Island WWTF upgrade were not acceptable.

- During the course of the piloting effort it was noted that the influent wastewater strength was higher than originally projected.

- The City is now planning to upgrade the Peirce Island WWTF to provide secondary treatment with the ability to achieve total nitrogen removal to a level of 8 mg/l (the previous projected loadings did not include nitrogen).
- Previous projections did not contain any allowance for future wastewater flow and load increases due to growth.

The projected flows and loads have been revised to address these changed conditions. Table ES-1 presents a summary of the revised projected future condition flows and loads. In addition to the average daily and maximum monthly flows noted in Table ES-2, the secondary process would be sized to treat a maximum daily flow of 9.06 mgd. The instantaneous hydraulic maximum flow through secondary will be established during preliminary design. Wet weather flows in excess of the secondary treatment system capacity would be treated through chemically enhanced primary treatment and disinfection.

Table ES-1. Projected Year 2032 Design Flows and Loads to Secondary

Parameter	Annual Average Day	Max Month
Flow (mgd)	6.13	8.86
Influent TSS (mg/L)	199	187
Influent TSS (lb/d)	10,176	13,853
Influent BOD_5 (mg/L)	195	161
Influent BOD_5 (lb/d)	9,959	11,881
Influent TKN (mg/L)	29.5	27.6
Influent TKN (lb/d)	1,511	2,039
Primary Effluent TSS (mg/L)	**99 - 147**	**94 - 138**
Primary Effluent TSS (lb/d)	**5,088 – 7,510**	**6,927 – 10,224**
Primary Effluent BOD_5 (mg/L)	**136 - 165**	**113 - 136**
Primary Effluent BOD_5 (lb/d)	**6,971 – 8,4357**	**8,317 – 10,063**
Primary Effluent TKN (mg/l)	**26.9 - 28.6**	**25.1 - 26.8**
Primary Effluent TKN (lb/d)*	**1,375 – 1,465**	**1,856 – 1,978**
CEPT Effluent TSS (mg/L)	**51**	**48**
CEPT Effluent TSS (lb/d)	**2,618**	**3,564**
CEPT Effluent BOD_5 (mg/L)	**121**	**100**
CEPT Effluent BOD_5 (lb/d)	**6,166**	**7,356**
CEPT Effluent TKN (mg/L)	**24.2**	**22.6**
CEPT Effluent TKN (lb/d)	**1,239**	**1,672**

Primary effluent loads and concentrations are presented as ranges based on constituent percent removals observed from the WWTF characterization data, observed pilot data, text book values, and CEPT removal.

The revised flow and loading projections have been used as the basis for the updated sizing of each technology as described in Section 5.

SECTION 5 – SECONDARY PROCESS RESIZING AND COMPARISON

This section presents updated process sizing, layouts, and estimated costs for each of the three piloted technologies. Each process has been sized for the revised flows and loads presented in Section 4 and configured to achieve secondary treatment with the ability to meet an effluent total nitrogen concentration of 8 mg/l.

Approach

In addition to pilot performance data, tank sizing, process requirements/limitations, capital costs, and operation and maintenance costs were developed for each technology. After completion of the pilot testing, revised full-scale proposals were requested from the technology vendors. The vendors were requested to provide a process design to meet secondary treatment with the ability to meet effluent total nitrogen of 8 mg/l. Using the information provided by the vendors, AECOM advanced the concept for each technology to a conceptual level design and were used as the basis of developing the capital and operation and maintenance cost estimates for the evaluation.

Capital Cost Comparison

Conceptual opinions of cost for the implementation of the three technologies to achieve secondary treatment with the ability to meet a total nitrogen limit of 8 mg/L were developed. The estimates combine components of the Wastewater Master Plan opinions of cost and new opinions of cost developed for the three technologies for secondary treatment.

The Wastewater Master Plan recommended a number of upgrades at the Peirce Island WWTF that would need to be implemented if the facility were upgraded to achieve secondary treatment with the ability to meet a total nitrogen limit of 8 mg/L using one of the three technologies considered. Accordingly, the Wastewater Master Plan opinion of cost for Headworks, Sanitary Disinfection, Biosolids Processing, and parts of Additional Structures and Modifications from "Compliance Strategy Cost Estimate Biomag Secondary Treatment" were added to the piloted technologies opinions of cost developed in this technical memorandum. It is recommended that costs taken from the Wastewater Master Plan be reevaluated to determine their suitability for the purposes of presenting a total upgrade cost.

The total estimated capital costs are conceptual planning level costs and have been developed based on a number of assumptions and may not represent the final project capital costs for the facilities once designed. The final costs could be higher or lower depending on what decisions are made during the design phase, how the final facilities are constructed, and when the final facilities are constructed. The preliminary opinions of capital cost for the three technologies presented in 2016 costs (based on the scheduled midpoint of construction) and are presented in Table ES-2.

Table ES-2. Opinion of Capital Cost Summary

Technology	Estimated Cost ($MM)
Biological Aerated Filter (BAF)	$60.5
Conventional Activated Sludge (CAS) with BioMag	$54.0
Moving Bed Bioreactor (MBBR) & DAF	$56.5

Operations and Maintenance Cost Comparison

Conceptual level estimated annual operation and maintenance costs for each candidate technology were developed. These estimates reflect only the operation and maintenance costs to support the proposed technology and are not inclusive of other processes at the Peirce Island WWTF. The estimates consist of annual costs for electricity, chemicals, labor and equipment replacement as shown in Table ES-3.

Table ES-3. Estimated Annual Operation and Maintenance Costs Summary

Item	BAF	CAS w/ BioMag	MBBR & DAF
Electricity	$390,000	$802,000	$540,000
Labor & Maintenance	$307,000	$354,000	$291,000
Chemicals	$219,000	$105,000	$383,000
Parts & Replacement	$192,000	$207,000	$176,000
Total	$1,108,000	$1,468,000	$1,390,000

Life Cycle Cost Comparison

20 year life cycle costs for each technology were evaluated. The present worth value of the operation and maintenance costs was developed using a period of 20 years and a present worth annual interest rate of 4.375 percent based on the United States Department of Agriculture's Natural Resources Conservation Service's discount rate for federal water projects. Table ES-4 summarizes the calculated life cycle costs.

Table ES-4. Estimated Life Cycle Costs Summary ($MM)

Cost Item	BAF	CAS w/ BioMag	MBBR & DAF
Capital	$60.50	$54.00	$56.50
20 Year Present Worth O&M	$14.60	$19.30	$18.30
20 Year Life Cycle	$75.10	$73.30	$74.80

With the limited definition of project elements and the number of unknown variables at this level of conceptual development, all three technologies can be considered essentially equal on a capital and life cycle cost basis.

SECTION 6 – NON-MONETARY EVALUATION FACTORS UPDATE

In the Phase 1 Evaluation, in addition to evaluating the capital and O&M costs for potential treatment technologies, a Criteria Evaluation Matrix was developed as a tool to quantify the subjective non-monetary aspects of the technologies. The evaluation criteria and the matrix have been updated. These updates were based on information and insight gained during the piloting effort of the three technologies. Some of the criteria used in the updated matrix were obtained from input from the WWTF operations staff through a questionnaire as well as day-to-day interaction, while others were developed by the project team and the City based on considerations resulting from the change in effluent treatment goals from secondary to total nitrogen removal to 8 mg/l.

The evaluation criteria used were as follows:

1. Operations Factors
2. Maintenance Factors
3. Health and Safety Factors
4. Operational Track Record/Established Process
5. Ability to Retrofit TN of 8 mg/l to Future TN of 3 mg/l
6. Response to Sustained Wet Weather Flows
7. Response to Process Disruption
8. Potential for Technology Optimization
9. Ability to Exceed Treatment Performance Goals

Technology Comparison and Ranking

For the criteria evaluation, a two step process was used to compare and rank the technologies. In the first step, the paired comparison technique was used to weigh the revised evaluation criteria. The weighted evaluation criteria are shown in Table ES-5.

In the second steps these criteria were placed in the Option Evaluation Matrix, shown in Table ES-6, where the three technologies are listed. In this table each technology was assessed to on how well the technology met each criterion. The points assigned to each technology for each criterion were then multiplied by the weighting factor, and the results summed to identify the non-monetary value points for each technology. The estimated capital cost and life cycle cost of each technology were added to the matrix and scores were divided by the costs (in millions) to obtain value ratios.

As indicated, the BAF had the highest life cycle cost value ratio of the three piloted processess and was tied having the highest capital cost value ratio.

SECTION 7 – PILOT TECHNICAL MEMORANDUM RECOMMENDATIONS

This section presents recommendations regarding the secondary treatment facilities upgrade of the Peirce Island WWTF resulting from the Phase 2 Initial Piloting program. The recommendations address the design and capacity of the secondary treatment facilities upgrade.

Secondary Treatment Facilities Design Capacity

Table ES-7 presents the recommended design flows and loads to secondary based on the use of conventional primary treatment. In addition to an average daily flow of 6.13 mgd, and a maximum month flow of 8.86 mgd, the secondary treatment facility will be designed to treat a maximum day flow of 9.06 mgd. The instantaneous maximum hydraulic capacity will be established during preliminary design. Wet weather flows in excess of 9.06 mgd will receive chemically enhanced primary treatment and disinfection.

Design Recommendations

The Phase 2 Piloting Evaluation was completed to identify the proposed size and design of facilities required to meet secondary treatment limits with the ability to meet a TN of 8 mg/l; to estimate the costs for those facilities; to compare the technologies to provide nitrogen removal to a TN of 8 mg/l based on cost and non-monetary factors; and to identify a recommended approach. It is recommended that the City proceed with the design and construction of a secondary treatment facility with the ability to meet a TN of 8 mg/l. As part of the design effort, consideration should be given to what further modifications to the recommended facilities would be necessary to meet a lower effluent TN limit should one be imposed.

Table ES-5. Criteria Evaluation Matrix

	B	C	D	E	F	G	H	I	Evaluation Criteria	Score	Weighting Factor
A	A 1	C 3	D 2	A 1	F 2	G 2	A 3	A 1	Operations Factors	6	10
	B	C 3	D 2	E 1	F 2	G 2	B 2	I 1	Maintenance Factors	2	3
		C	C 1	C 2	C 2	C 2	C 2	C 2	Health & Safety Factors	17	27
			D	D 2	D 1	D 1	D 2	D 2	Operational Track Record/Established Process	12	19
				E	F 2	G 2	E 1	I 1	Ability to Retrofit TN of 8 mg/l to Meet TN of 3 mg/l	2	3
					F	G 1	F 1	F 1	Response to Sustained Wet Weather Flows	8	13
						G	G 2	G 2	Response to Process Disruption	11	18
							H	I 2	Potential for Technology Optimization	0	0
								I	Ability to Exceed Treatment Performance Goals	4	6
										Total	100

Key

Evaluation criteria are used to compare the alternatives
Score is the total number of points accumulated for each criterion
Weighting Factor is the relative values of each criterion

Ranking

1 – Slghtly more important than the other criterion it is being compared with
2 – Somewhere between extremes of importance
3 – Much more important than the other criterion it is being compared with

Table ES-6. Option Evaluation Matrix

Evaluation Criteria	Weight	BAF		CAS-BioMag		MBBR-DAF	
		Rating	Score	Rating	Score	Rating	Score
Operations Factors	10	3.0	30	2.1	21	3.2	32
Maintenance Factors	3	3.2	9.6	1.6	4.8	3.5	10.5
Health & Safety Factors	27	3.2	86.4	2.0	54	3.3	89.1
Operational Track Record/Established Process	19	4.0	76	2.0	38	3.0	57
Ability to Retrofit TN of 8 mg/l to Meet Future TN of 3 mg/l	3	5.0	15	2.5	7.5	3.0	9
Response to Sustained Wet Weather Flows	13	3.5	45.5	4.0	52	3.5	45.5
Response to Process Disruption	18	4.0	72	3.0	54	4.0	72
Potential for Technology Optimization	0	2.5		2.5		4.0	
Ability to Exceed Treatment Performance Goals	6	3.0	18	4.0	24	3.0	18
Total Weighted Criteria		353		255		333	
Capital Cost (estimated - in millions)		$60.5		$54.0		$56.5	
Value Ratio (criteria/capital cost)		5.8		4.7		5.9	
Life Cycle Cost (in millions)		$75.1		$73.3		$74.8	
Value Ratio (criteria/ life cycle cost)		4.7		3.5		4.5	

Rating 1-5. 5 is the most advantageous. 1 is the least advantageous.

Table ES-7. Secondary Treatment Facilities Design Capacity

Parameter	Annual Average Day	Max Month
Flow (mgd)	6.13	8.86
Influent TSS (mg/L)	199	187
Influent TSS (lb/d)	10,176	13,853
Influent BOD_5 (mg/L)	195	161
Influent BOD_5 (lb/d)	9,959	11,881
Influent TKN (mg/L)	29.5	27.6
Influent TKN (lb/d)	1,511	2,039
Primary Effluent TSS (mg/L)	**99 - 147**	**94 - 138**
Primary Effluent TSS (lb/d)	**5,088 – 7,510**	**6,927 – 10,224**
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Primary Effluent BOD_5 (lb/d)	**6,971 – 8,4357**	**8,317 – 10,063**
Primary Effluent TKN (mg/l)	**26.9 - 28.6**	**25.1 - 26.8**
Primary Effluent TKN (lb/d)	**1,375 – 1,465**	**1,856 – 1,978**

Primary effluent loads and concentrations are presented as ranges based on constituent percent removals observed from the WWTF characterization data, observed pilot data, text book values, and CEPT removal.

Based on the data and evaluation presented in the report, the BAF technology was judged to provide the City with the highest value. Accordingly, this technology is the recommended technology for upgrading the Peirce Island WWTF to secondary treatment. This recommendation is based on the following

1. Secondary treatment facilities sized to treat the flow and loads presented in Section 4 and Attachment C.

2. Secondary treatment effluent limits apply to the effluent from the secondary treatment process prior to combining the secondary effluent with wet weather flows for discharge.

3. The ability to achieve an effluent total nitrogen of 8 mg/l through the secondary treatment facilities based on a seasonal rolling average for April through October.

4. Achieving 85 percent removal of BOD and TSS through the secondary treatment facilities is only required during dry weather days as defined in Attachment C.

Once an NPDES permit is issued which defines the requirements that the upgraded facility will be required to meet, the recommendation for a secondary treatment facility using the BAF technology can be reviewed and revised as needed.